Academia Journal of Scientific Research 7(5): 282-287, May 2019
DOI: 10.15413/ajsr.2019.0109
ISSN 2315-7712

Academia Publishing

Research Paper

The teaching of basic mathematical concepts to pre-service teachers in universities: A case of mountains of the moon university, Uganda

Accepted 7th February, 2019

ABSTRACT

Mathematics is a key during teaching and school management; the relevance of teaching basic mathematics to the pre-service teachers at universities was investigated. A random sample of 80 pre-service teachers was used and a quantitative experimental design adopted. The results indicated that there was a significant difference at 0.05 level between the mathematical concepts pre-service-teachers at entry and end of the basic course in mathematics; there was no significant difference at 0.01 level between the pre-service teachers' scores in basic mathematics and their subjects of specialization at the start of the course but the difference was significant at 0.01 level at the end of the course. Also, there was a change in the pre-service teachers' mindset about the course over time during the teaching and learning process.

Key words: Pre-service teachers, basic mathematics and teaching.

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INTRODUCTION

The role of mathematics in the teaching and learning process does not need to be told to any individual or society. This explains why the subject is considered among the most important subjects in Ugandan education system. Mathematics has been regarded as the foundation of science and technology (Odumosu et al., 2001). The process of teaching as well as, school management requires some basic concepts of mathematics especially during planning, accountability, budget control, assessment and evaluation and management of change. There is hardly any area of science that does not make use of mathematical concepts to explain its own concepts, theories or models. Simeon and Francis (2012) discoursed that mathematics is the queen of science and technology and also a tool for scientific and technological development; similarly, mathematics is regarded as the major tool available for formulating theories in science, engineering, and economics as well as, in other fields like education. However, according to Opolot-Okurot (2005), majority of the students at all levels of education have a low attitude towards the subject.

Teachers are researchers in their own classrooms, they provide guidance to their learner and this comes after a simple investigation about the problem at hand. Teachers handle students' data such as examination scores and students' bio data; all these require proper presentation, analysis and relevant recommendations for new innovations in schools.

School managers such as directors of studies, deputy head teachers and head teachers do a lot of planning, budgeting, forecasts and projections that require the knowledge of mathematics. As an attempt to close this gap, students enrolling for teaching courses at universities are introduced to basic mathematics that is aimed at instilling in them the relevant mathematical concepts such as data handling, numerical concepts, matrices, equations and relationships, these concepts according to Kurniz (2008) requires a gradual process.

Owing to the role and application of mathematics, all pre-service teachers in universities are introduced to basic mathematical concepts that are sought to help them during the teaching and learning process. The question in this study is whether students who enroll for teaching related programs at universities do not have these concepts. The purpose of this study is to establish the difference between

the mathematical concepts pre-service teachers have at entry and what they have at the end of the basic mathematics course in order to establish the relevance of teaching the course unit.

Main objective

The main objective of this research is to establish the relevance of teaching basic mathematics to the pre-service teachers in Universities.

Hypotheses

The hypotheses used in this research include:

H_o: There is no difference between pre-service teachers' mathematical knowledge at entry and at the end of the basic mathematics course;
H_1: There is no difference between pre-service teachers' scores in the basic mathematics course and their subjects of specialization at the start of the course;
H_2: There is no difference between the pre-service teachers' state of mind about the basic mathematics course at the start and at end of the course.

MATERIALS AND METHODS

Pre-service teachers who registered for Bachelor of Arts with Education and Bachelor of Science with Education in first year of 2018/2019 at Mountains of the Moon University constituted the sampling frame. The total number of registered pre-service teachers was 185 from which a sample of 80 respondents was randomly selected. An experimental design was adopted according to the method described by Bandura (1977), Best and Kahn (1999) and Brewer (2005). Two data sets were collected at the start and at the end of the course. The first data set consisted of a test that was aimed at finding out the level of mathematical knowledge of the pre-service teachers and the questionnaire that captured the mindset of the pre-service teachers at the start of the course. The second data set had similar tools with an aim to measure the change in the mathematical knowledge and mindset of the pre-service teachers. The data was analyzed using the statistical package for social scientists (SPSS).

RESULTS AND DISCUSSION

Level of pre-service teachers' mathematical knowledge

The pre-service teachers' level of mathematical knowledge such as ability to solve equations, data handling, dealing with numbers, graphs and logical thinking was measured at two levels. The 1st measurement test was at the at the start of the semester before the basic course in mathematics was taught, while the 2nd measurement test was at the end of the semester after the basic course was fully taught to the pre-service teachers.

The 1st test was administered to eighty randomly selected pre-service teachers; it measured the concepts such as data handling, equations, graphs, numerical concepts and matrices that are covered by basic mathematics. The results of the test were compared between two major characteristics of the pre-service teachers; the gender and the subject of specialization. The subject of specialization was conceptualized in two categories: pre-service teachers specializing in mathematics and those not specializing in other subjects not mathematics.

Distribution of students' scores in test 1 and 2 by gender

The tests were administered to eighty (80) pre-service teachers in the same conditions, one at the start of the semester and the other at the end of the semester. Table 1 shows the illustration of the distribution of the pre-service teachers' scores. According to Table 1, the mean of the pre-service teachers' scores in test 1 was 22 and 25 for female and male teachers, respectively. This indicates that there was a difference between the scores obtained by female and male teachers in test 1 with male pre-service teachers performing better than females. In the study by Ajai and Imoko (2015), such difference was registered but was not found to be significant. The median score in test 1 was 20 and 25 for female and male teachers, respectively, while the most common score was 25 for both female and male teachers. The inclusive (overall) mean is to the right of the mode of test 1; hence, the distribution of the scores is positively skewered with Pearson coefficient of skewness as 0.7 and 1.0 for females and males, respectively. The kurtosis is 1.1 which is positive, indicating that the shape of the distribution is not flat and the median is 25 indicating that 50% of the pre-service teachers have scores of 25 and below. The inclusive standard deviation is 7.4; this indicates that teachers' scores slightly deviated from that of men.

Similarly, the mean of the students' scores in test 2 were 62 and 66 for female and male teachers, respectively, while the inclusive mean was 64.5. Like in test 1, the means of test 2 indicate a knowledge difference across gender. The kurtosis for test 2 is -0.1, indicating that the distribution of test 2 is flat. The inclusive median is 65 and the mode is 65, this indicates that 50% of the students had scores of 65 and above. Also, it is noted that the inclusive mean, mode and median of test 2 are almost the same, indicating that the distribution is almost normal. The inclusive standard deviation of test 2 is 16.3; this suggests that 68% of the

Table 1: Summary statistics for Test 1 and Test 2 by gender.

Statistics	Test 1			Test 2		
	Female	Male	Inclusive	Female	Male	Inclusive
Mean	22	25	24.0	62	66	64.5
Median	20	25	25.0	65	65	65.0
Mode	25	25	25.0	65	60	65.0
Standard deviation	6	8	7.4	14	18	16.3
Kurtosis	0.1	0.9	1.1	0.8	-0.6	-0.1
Skewness	0.7	1.0	1.0	-0.6	0.1	0.1
Range	25	33	35.0	60	70	75.0
Minimum	13	15	13.0	25	30	25.0
Maximum	38	48	48.0	85	100	100.0

Table 2: Test for the difference between the mean scores of test 1 and 2.

Statistics	Values
Mean score for Test 1	24
Mean score for Test 2	64.5
Standard deviation for Test 1	7.4
Standard deviation for Test 2	16.3
Sign. α (2 tailed)	0.05
Critical value $Z_{\frac{\alpha}{2}}$	1.96
Test statistic z	20.2

students have mean scores between 48.2 and 80.8.

The results in Table 1 further indicate that there is a difference between the teachers' scores in test 1 and 2. It is noted that the mean difference across gender between test 1 and 2 was found to be almost the same. This indicated consistency in knowledge difference between female and male teachers; this is supported by Ajai and Imoko (2015). The results also show an increase in the mean scores for both female and male teachers; this is probably attributed to the knowledge the pre-service teachers obtained from the basic mathematics course an indication that the course results into additional knowledge and as such is relevant to the pre-service teachers. The distribution of the scores shifted from being positively skewed in test 1 to almost normally distributed in test 2. The range of the scores in test 1 was 35 as compared to 75 in test 2; this indicates that the rate of knowledge achievement of pre-service teachers with high scores in test 1 was high compared to their counterparts with lower scores in test 1. This therefore, suggests that the background knowledge of the students has a significant effect on the subsequent knowledge achievements. This is indicated by Pearson correlation coefficient r = 0.4869, which is however a weak relationship between the two levels of knowledge.

Comparison between pre-service teachers' scores in test 1 and 2

The main question addressed in this sub-section is whether there is a mathematics knowledge difference before and after the teaching of the basic mathematics course to the pre-service teachers at universities. The mathematics knowledge level was measured in terms of awareness and application of mathematical concepts that the basic mathematics course aims at. Table 2 shows the distribution of the relationship between the two test scores illustrated.

Table 2 indicates results of the hypothesis test for the difference between the 2 means from the two tests. The null hypothesis being tested is H_0: There is no difference between the pre-service teachers' mathematical knowledge at entry and at the end of the basic mathematics course, that is, there is no difference between the pre-service teachers' mean scores in both tests. The results indicate that the test statistics (20.2) is numerically greater than the critical value (1.96). In this case, the null hypothesis is rejected implying that there is a significant difference between the pre-service teachers' mathematical knowledge

at entry and at the end of the basic mathematics course at 0.05 level.

Relationship between pre-service teachers' scores and their subjects of specialization

The students' scores in the second set of measurement were analyzed against their subjects of specialization. The subjects considered were History, Geography, Mathematics, Physics, Agriculture, Economics, entrepreneurship, Religious Studies and Fine Art. These subjects were sub-divided into two groups of mathematical subjects (Mathematics, Economics and physics) and non-mathematical (History, Entrepreneurship, Geography, Religious Studies, Agriculture and Fine Art). The analysis was done within and across groups with the aim of comparing students' scores across subjects and groups.

Students' gender and pre-service teachers' of specialization

The distribution of the participants comprised of 39% female and 61% male, while 26% were specialized in mathematics of which 19% were females and 81% were males; 74% were specialized in other subjects such as History, Geography, Economics, Fine Art and Religious studies of which 46% were females and 54% males. These results indicate that more male participated in the study than the female teachers; similarly, teachers specialized in mathematics were less compared to those specialized in other subjects. The number of female teachers specializing in mathematics is much less than the male teachers specializing in the subject with a percentage range of 62% which is much bigger than the percentage range of 8% between the female and male teachers specializing in other subjects.

Pre-service teachers' scores in test 1 and 2 by subject of specialization

The main question discoursed here is whether the students' test scores in basic mathematics differ by their subjects of specialization or not. Tables 3 and 4 show the summary of the related results.

Table 3 indicates that there is a difference between the mean score of mathematics teachers and non-mathematics teachers in test 1; however, this difference is not significant at 0.01 levels as indicated in Table 4. Similarly, there is a difference between the mean scores of the teachers in test 2 and this difference is significant at 0.01 level as illustrated in Table 4. These results indicated that all the teachers had almost the same knowledge level at the start of the semester, however; there was a significant difference at the end of the basic course between teachers specialized in mathematics and those specialized in other subjects other than mathematics. This also indicated that the content of the course unit is required by all the teachers irrespective of their subjects of specialization, but teachers not specialized in mathematics should be given a high level of attention as their rate of internalizing mathematics concepts is low as compared to their counterparts.

Pre-service teachers' mindset about the basic mathematics course

The variation in pre-service teachers' mindset about the basic mathematics course offered at the university was measured using a 5 Likert scale questionnaire. The questionnaire covered the teachers' interest in the course, ability to make a study plan, awareness of the applicability of the course, having a hope of passing the course, willingness to study the course continuously, ability to patiently solve related problems and students' confidence level (Figure 1).

Figure 1 indicates the teachers' mindset about the basic mathematics course. The teachers who showed a high level of interest in the basic mathematics course at the start of the course were 65% and this increased to 69% at the end of the teaching. Teachers were also asked whether the course unit is their favorite or not; at the start of the course very few (30%) indicated that the course was their favorite, while 70% ranked the course among the desired course units. The results at the end of the course indicated a slight increase in the number of teachers who felt the course unit was their favorite, however, the proportion was still low, this is attributed to the low attitude learners have about mathematics generally.

At the beginning most teachers indicated that they had no study plans for the course, only 45% reported the use of discussion groups, self-reading and use of e-learning resources as their study plans. By the end of the course 65% of the teachers had developed a relevant study plan. These were stirred by the class exercises and tests. This indicates that learners have no study plan at the beginning of any particular teaching but develop the plan during the teaching process. Teachers and other instructors need to ensure that learners are engaged in numerous activities to ensure that they develop a study plan for success.

The application of basic mathematics course in teaching and learning were not recognized by the pre-service teachers at the start of the course and only 21% of the teachers indicated that the course is relevant and has application in the teaching and learning process. However, after the teaching, the proportion of the teachers with a positive mindset about the applicability of the course in teaching was 95%. This change in mindset was reported to be as a result of the number of practical exercises the students could have engaged in during the lessons; one of

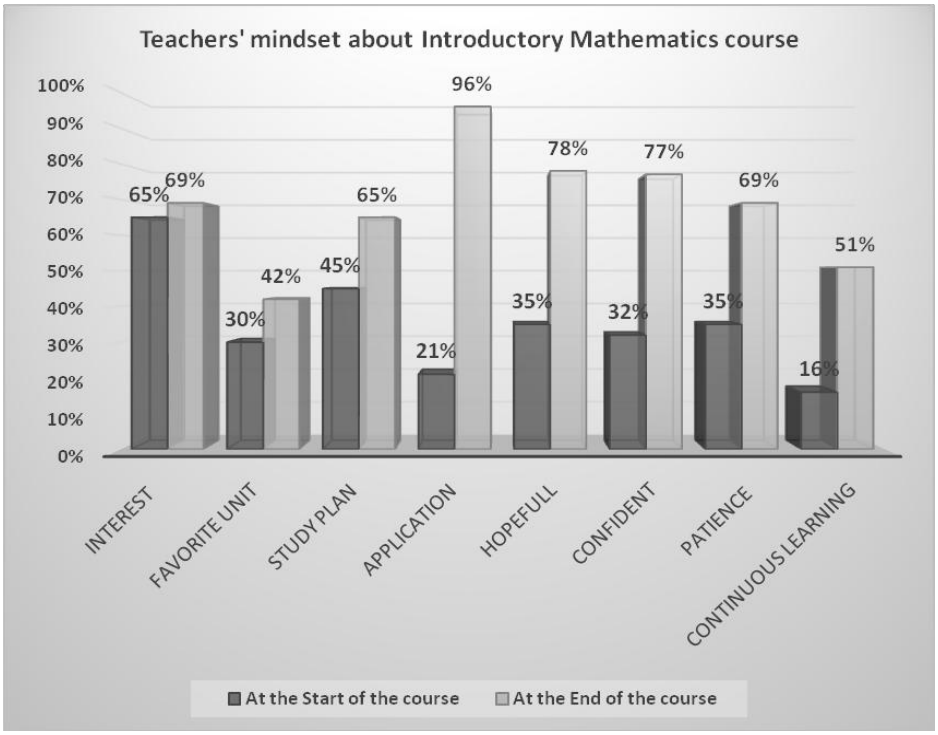

Figure 1: Distribution of pre-service teachers' mindset about the basic mathematics course.
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Table 3: Distribution of pre-service teachers' scores in Test 1 and Test 2 by subject of specialization.

Statistics	Mathematics teachers		Non-mathematics teachers	
	Test 1	Test 2	Teat 1	Test 2
Mean	28.3	79.0	22.5	59.4
Median	28.0	80.0	20.0	60.0
Mode	25.0	85.0	25.0	65.0
Standard deviation	6.3	14.4	7.2	13.7
Kurtosis	1.0	-0.4	2.8	0.5
Skewness	0.4	-0.4	1.5	-0.1
Range	28.0	50.0	35.0	70.0

Table 4: Test for the difference between the mean scores of test 1 and 2 for the Mathematics teachers and non-mathematics teachers.

Statistics	Test 1	Test 2
Mean score for Mathematic students	28.3	79.0
Mean score for Non-Mathematics teachers	24.4	59.0
Standard deviation for Mathematics teachers	6.3	14.4
Standard deviation for Non-Mathematics teachers	7.2	13.7
Sign. α (2 tailed)	0.01	0.01
Critical value $Z_{\frac{\alpha}{2}}$	2.57	2.57
Test statistic z	2.2	5.6

the student narrated that "this course is a reality in schools, I can now make a teaching timetable of a school wawooo….".

Figure 1 also indicated that the students had little or no hope of passing the course unit at the beginning, only 35% reported that they are hopeful about passing the course unit. This was also reflected by level of teachers' confidence in mathematics. The number of teachers who reported as having hope for passing was almost equal and proportional as those who showed a high level of confidence. The proportion of the teachers who had patience and love to continue studying the course also increased from 35 and 15% to 67 and 51%, respectively. In general, there was a difference between the pre-service teachers' mindset at the start of the course and at the end of the course; these results are in line with what Akin and Izzet (2011) and Tam (2017) obtained about variation in students' mathematics mindset.

Conclusion

The teaching of the basic mathematics course is relevant to all students enrolling for teaching related courses as pre-service teachers at universities. The study yielded two important results: (1) Students enrolling at university in the teaching courses have a knowledge gap on mathematical concepts that are frequently used during the teaching and learning process and this gap does not depend on their subjects of specialization. However, the pre-service teachers specialized in mathematics have a high level of knowledge grasping and application than those specialized in other subjects like History, Geography, Religion, Economics and Agriculture; (2) Pre-service teachers and other learners have a negative mindset about courses at the start of the teaching but develop a positive mindset as the teaching go on and after interacting with the content and practical examples of the course.

RECOMMENDATIONS

The basic mathematics course should be emphasized in all teacher training institutions to close the existing knowledge gap on mathematical concepts relevant to the teaching process. The teaching of this course should highly engage those whose subject of specialization is mathematics. Care should be taken as learners (pre-service teachers') mindset is always negative as far as mathematics is concerned but they have an ability to change as they interact with the content of the course. Such courses should only emphasize application of content rather than just knowledge.

Further research may be conducted to ascertain the performance gap in schools that may exist between teachers who were introduced to basic mathematics course and those who were not introduced to the course during their training time.

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